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ABSTRACT

Drawing from experience at Lansing Community College (LCC), this paper discusses how to best prepare students for success in a beginning algebra course. First, an overview is presented of LCC's developmental math sequence, which includes Basic Arithmetic (MTH 008), Pre-Algebra (MTH 009), Beginning Algebra (MTH 012), and Intermediate Algebra (MTH 102). Next, data are presented, showing the annual pass rates in MTH 012 for students who first passed MTH 009 and for all other MTH 012 students. The data point to a trend from 1980 to 1984 of improved MTH 012 performance among MTH 009 students, and a reversal of that trend in 1984-85. The next section explains the basic structure of MTH 009 and 012, explaining that both courses are offered in a self-paced, competency-based, math laboratory environment; and that both use a text and workbook in conjunction with individualized instruction as needed. Next, instructional changes that took place in the MTH 009 classes are examined, including a change in textbook, elimination of supplementary "packets," and an increase in mastery requirements. The final sections offer a discussion and analysis of the lower MTH 012 pass rates of MTH 009 students, underscoring the importance of providing students with a general framework of ideas, concepts, and skills (including appropriate vocabulary) in order to help them grasp algebraic topics which are usually abstract in both content and approach. (RO)

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READINESS AND PREPARATION FOR BEGINNING ALGEBRA

by

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READINESS AND PREPARATION FOR BEGINNING ALGEBRA

Jack W. Rotman Lansing Community College May 1986

ABSTRACT

An ongoing concern of math educators is how to best prepare students for success in a beginning algebra course. Based on experience at Lansing Community College, some concerns for pre-algebra instruction and textbooks are raised. In particular, the concepts of "training" (limited) and "education" (generalized) seem powerful and robust with ideas for helping students make this transition.

One of the long-standiing questions for math educators is that of subsequent course performance. That is: What can be done in course X to enhance student success in course X + 1? What can be done in course X + 1 that will especially help students who have had course X? In this paper, I will be discussing the transition from pre-algebra to beginning algebra, based on experience at a community college.

Here at Lansing Community College, we enroll over 1000 students per term in our developmental math sequence, out of about 20,000 students for the entire institution. The developmental math courses are:

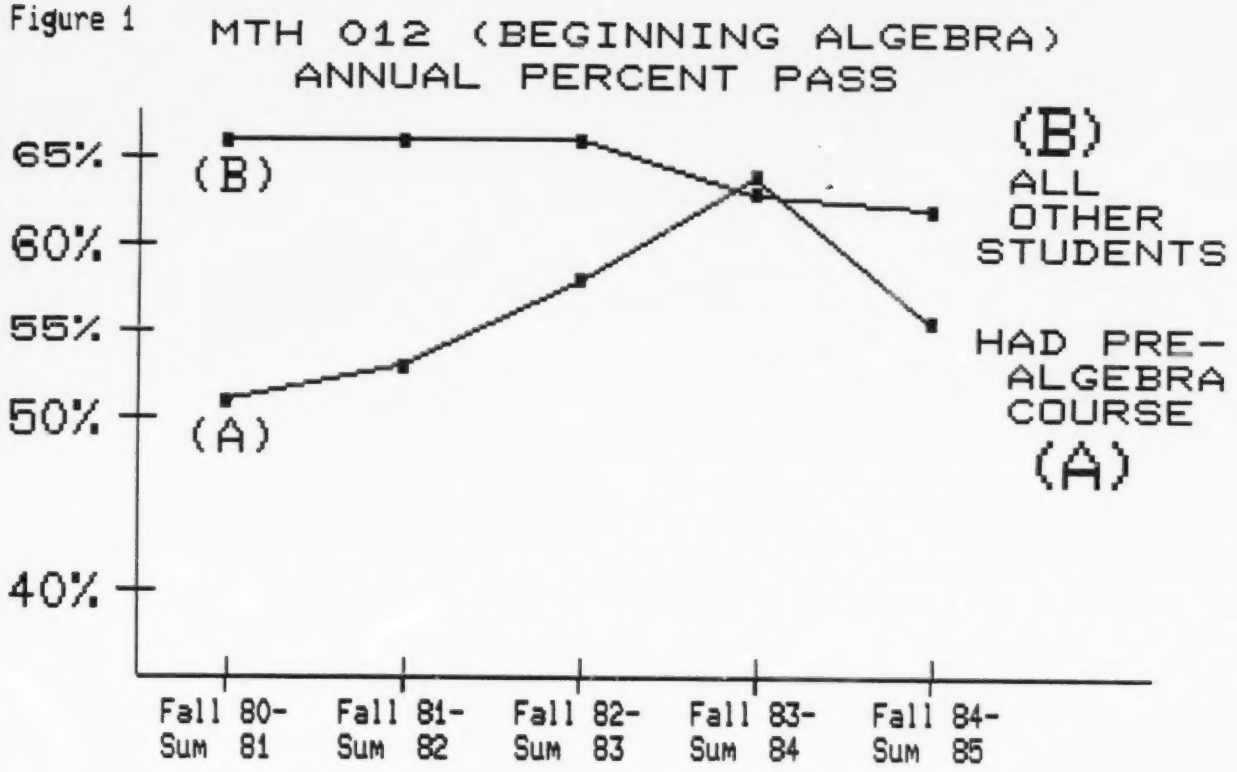
MTH 008	Basic Arithmetic
MTH 009	Pre-Algebra
MTH 012	Beginning Algebra
MTH 102	Intermediate Algebra
[MTH 164	College Alg and Trig I] -- first non-developmental course

Our data indicates that about 70 to 80% of the students in any one of these developmental courses plan to take the next course in the sequence. Figure 1 on page 2 shows the annual pass rates in MTH 012 for two groups:

A. MTH 012 students who passed the pre-algebra course (MTH 009), and

B. all other MTH 012 students (who are primarily those starting MTH 012 based on their placement test, plus those repeating MTH 012 from a prior term) .

Figure 1



NUMBERS IN GROUPS ABOVE

	80-81	81-82	82-83	83-84	84-85
A (had 009)	224	245	374	380	382
B (others)	555	612	868	798	700

All differences between the passing rates of the two groups are statistically significant except for the 1983-84 year. The year to year changes for the 'had pre-algebra' group are not statistically significant except for the 1984-85 year compared to the prior year. For the 'other' group, only the overall change for the entire period is statistically significant, and this is not a strong difference.

What is especially interesting about the data is that it appears that, from 1980 to 1984, we had a trend for improved performance from the pre-algebra alumni; this occured to the point where their MTH 012 pass rate equalled that of the other beginning algebra students. However, the situation has worsened again in the 1984-85 year. By comparison, the performance of MTH 012 passing students who go on to MTH 102 has remained fairly constant over the same period.

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THE SETTING: the basic structure of the courses

MTH 009 (pre-algebra) is taught strictly in a self-paced environment. The Math Lab requires students to pass each Test, including the final, in order to pass the course. Students are placed into MTH 009 (and the other courses) either by their score on our math placement tests, or by passing the prerequisite course. Most of the instruction in MTH 009 is based on using a text/workbook; instructors are available for individual assistance in the Math Lab. Students use this instruction when they feel the need or when they fail a test. Some aspects of the instructional process changed over the period in question. See the discussion of changes below.

MTH 012 (beginning algebra) is taught in the Math Lab self-paced environment and in a traditional classroom setting. The vast majority of the students use the self-paced mode (about 75 to 80%). The data above includes only the self-paced sections of MTH 012, so that those aspects of the learning system are similar to those in pre-algebra (MTH 009). In MTH 012 in the Math Lab, the instruction is again based on using a text/workbook and individual instruction, though there is more emphasis on an optional weekly 1 hour lecture.

In each course, the student is expected to pass about 1 test per week for our 11 week term. A suggested test schedule and a minimum of deadlines are used to help the student pace their work; letters and some phone calls are employed to contact those who progress at a much slower pace than the suggested schedule.

THE CHANGES: What happened in the period?

In MTH 009: Until 1984, MTH 009 used Keedy/Bittinger's Arithmetic (3rd ed) as the text, which was heavily supplemented by a set of "packets" written by our staff. In this period, there were 11 Tests in the course; of these 11, one test covered signed numbers and basic algebra. This test on algebra included the distributive property and solving simple linear equations with one or two terms on each side; only integers were used, as other rational numbers were not covered. In 1981, optional weekly 1 hour lectures were offered, and the trend has been for a higher proportion of MTH 009 students to enroll in these. Bonus points were awarded for attendance, which could raise the overall average for the grade by about 1.5%. Until 1983, our mastery level was 70%; in Fall 1983, it was raised to be 75%.

In 1984, MTH 009 began using Aufmann/Barker's Basic College Mathematics (2nd ed) as the text. No packets were used. The course had 10 tests, 1 of them on signed numbers (including non-integers), and 1 test on basic algebra. The distributive property is not covered, though combining like terms and solving simple linear equations is covered as before. For the weekly lectures, bonus points were not awarded beginning in Fall 1984.

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(changes in the period, continued)

In MTH 012: Until 1983, MTH 012 used Keedy/Bittinger's Introductory Algebra, 3rd ed, as the text. It was supplemented by 1 packet on the linear equations chapter until 1982; after 1982, no packets were used. With this text, there were 11 tests covering a fairly normal content. For the entire period, students were required to enroll for a weekly 1 hour lecture section. Bonus points were given for attendance as in MTH 009. The mastery level was 70% for the entire period with this text.

In 1983, MTH 012 began using Miller/Lial's Introductory Algebra, 2nd ed, as the text. With this text, there are 10 tests covering a very similar content. For each test, there is a 1 page "Study Guide" which lists the assignments and also provides short notes plus a list of references for extra help. As in MTH 009, the required mastery level was changed to 75% in Fall 1983. In Fall 1984, the bonus points for lecture attendance were dropped.

During the overall period, the percent of students passing MTH 009 who actually took MTH 012 in the Math Lab rose from 37% to 50%. Within MTH 012, the percent of all students who had passed MTH 009 prior to taking MTH 012 rose from 29% to 35%.

General changes: In Fall 1982, the Math Lab moved to a much larger facility in response to increased demands for its courses. In spite of this, the Math Lab sections tended to fill up to capacity long before the College registration period ended until 1984. In 1984 - 85, the enrollment in the Math Lab sections remained just below capacity in general.

DISCUSSION

In the period from Fall 1981 to Summer 1984, there is a steady trend for improved MTH 012 performance by students who had passed MTH 009. Even more dramatically, this group of students has regressed in 1984 - 85 to the performance level of 1981 to 1983. On the other hand, the performance of the other students has not changed very much in any given year. Based on these observations, it seems that some factor or factors caused the MTH 012 performance of those who passed MTH 009 to decline in 1984 - 85; and that these factors could be changes in MTH 009, or changes in MTH 012.

First, let's consider changes in MTH 012 (beginning algebra). The only change unique to the 1984 - 85 year was the dropping of lecture attendance bonus points. This definitely did have the effect of reducing the rate of attendance, but our staff does not feel that lecture attendance is a causal factor in course pass rates. Other than lectrue attendance, other measures of MTH 012 remained constant from Fall 1983 to Spring 1985 (such as average test scores). The change in MTh 012 textbook in 1983 coincides with the increased pass rates for pre-algebra alumni; however, this increased pass rate was not maintained after 1984. For these reasons, it seems most likely that there are course changes causing the reduced pass rates which lie in MTH 009.

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(discussion, continued)

Within MTH 009 (pre-algebra), the lower pass rates in MTH 012 coincides with the change in MTH 009 textbook, which included the dropping of the Packets which had been used. If the textbook itself is a factor, there are a number of considerations. First of all, the Keedy/Bittinger MTH 009 text uses the same format and structure of presentation as the Miller/Lial MTH 012 text. The fact that the text structures are similar may have helped students who had MTH 009 as they learned in MTH 012, though this seems a relatively minor effect. In addition, the style of the Keedy/Bittinger text often involved the student in extending the presentation ot exercises that had slight variations. In this sense, the book helped the students get an education about applying basic properties to a variety of settings, as opposed to a training where the examples and practice are matched closely.

In the case of the Aufmann/Barker text, the basic feature of the presentation is the use of matched examples, where the student's problems match the worked examples; the exercises are more closely matched to the examples than with the Keedy/Bittinger text. As a result, test scores tended to rise with the use of Aufmann/Barker, but the student was not faced with the same challenge. The Aufmann/Barker text is more of a training text; its main focus is on skill mastery within well defined limits. Another factor with the Aufmann/Barker as it relates to MTH 012 performance is just the fact that the structure is different; this does not seem to be a factor of generally major importance.

Along with the texts, one must consider the MTH 009 Packets, and their possible impact on MTH 012 performance. One of the major purposes of the Packets was to supplement the textbook in some areas, especially where it was felt the text was not clear or was at too low a level of difficulty. However, the Packets also placed a higher emphasis on vocabulary, and provided the student with a summary of the material. The summary may have been of significant help for those going on to MTH 012 by encouraging an organized review. Currently, with Aufmann/Barker, the student has no summary, and is simply told to do problems as a review method.

The Packets gave these elements of support to the student's education (as opposed to just training): more explanation, emphasis on vocabulary, and a summary for reviewing. In particular, vocabulary mastery and review are ways to help students generalize what they learn, and not have their skills confined to a narrow range. The packets may have helped students see more readily where their pre-algebra skills apply in beginning algebra as they went on to MTH 012.

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ANALYSIS

In one of my classes, there was a man who had been somewhat successful in his prerequisite course work, but was having some trouble with the current course (which happened to be intermediate algebra). Basically, he had trouble in identifying which skill or procedure to apply to each problem; as a result, I was explaining the pros and cons of some alternate methods for a particular type of problem. This he found distressing, and he stated: "I'm a marine infantryman; I just want one simple way to 'gut' them all out."

It seems to me that this student, as do many of our students, feel that math is a collection of essentially separate trenches, foxholes, and battlefields, each to be mastered given sufficient directions from a higher authority. Their vision is therefore limited by the field of vision they have from their current location (foxhole, trench, or battlefield). They are after basic training, a boot camp for math soldiers.

It seems clear to me that, as mathematicians and educators, we have much more to offer than boot camp. Pre-algebra should not be another name for Fort Dix or Camp Grayling, but a place to develop the mathematics abilities in general ways and to help students expand their view of how math is learned. In the terminology of Piaget, we should be concerned with providing experiences to help a person move to a more formal level of functioning, where more accomodation and assimilation take place. This is also connected to modes or systems of representation, and linguistics, which have had some research related to developmental math and college math. (See Mathematics Learning Problems and Difficulties of the Post Secondary Students, edited by M. J. Behr and G. W. Bright, 1983, published by the Center for Teaching/Learning of Mathematics, Farmington, Massachusetts, for some interesting articles.) Certainly for those who need to progress to college algebra, pre-calculus, calculus, or similar courses, these concerns are as important (or more important) than the mastery of an overabundance of discrete skills.

In my view, this approach also applies to the other parts of a math sequence. Our challenge is to help students become more flexible and powerful in learning new concepts, and to make appropriate use of previously learned concepts.

Certainly, my conclusion here is not new. Alternatives such as a "problem solving" approach to teaching mathematics have been advocated by many for quite some time. An article by Ann Chisko mentions some data for increased subsequent course performance after a problem solving approach was used (see "Developmental Math: Problem Solving and Survival", in the Mathematics Teacher, November, 1985). Also, a higher emphasis on vocabulary and study techniques (especially review) have been mentioned in the literature over the last two decades.

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CONCLUSIONS

First and foremost, we need to focus on providing an education as we prepare students to begin an algebra course. That is, our goals should involve a general framework of ideas, concepts, and skills, including the vocabulary that is appropriate.

This is not to say that we should ignore what has been learned about learning objectives and mastery learning. However, a pre-algebra course needs to do more than run a student through a skill mill, no matter how it is taught. The use of learning objectives tends to focus our attention on skills and training; they can, however, be applied to the learning sought in a more educational style program.

A pre-algebra course is the most developmentally based math course offered, whether in a secondary school setting or a college setting. That is, we need to help the pre-algebra student develop, and become more able to understand mathematics. The pre-algebra <u>skills</u> needed in beginning algebra are actually fairly limited, and are easily reviewed by many students. The main issue is:

> Can the student learn an idea (such as a property of equations or a process to add rational expressions) AND then see how these apply to a variety of problems, AND have some idea of when the knowledge does not apply?

I am not advocating that we consider every topic in total generality in a pre-algebra or beginning algebra course. I am suggesting that students are better served by an emphasis being more on learning a generalized procedure, rather than memorizing; this should include some notion of what the limits of this knowledge might be. This abstract, somewhat formal, approach to arithmetic (concrete) topics can improve a person's ability to grasp algebraic topics, which are usually abstract in both content and approach.

Even at the college level, we can not assume that the majority of students can function at this abstract level in mathematics. It will be much to the students -- and our -- advantage if we design courses to help students become more able to function at an abstract level.

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